1348271

PATENT SPECIFICATION

(11) 1348271

(21) Application No. 5324/71 (22) Filed 24 Feb. 1971

(44) Complete Specification published 13 March 1974

(51) International Classification B44D 1/24//B32B 3/12

(52) Index at acceptance

B2E 219 23Y 248 285 286 28Y 305 307 31Y 323 336 339 33Y 345 34Y 356 35Y 372 435 436 43Y 44Y 478 496 49Y 508 532 536 54Y 555 55Y 566 568 56Y 578

(19)

(72) Inventors MARK WALDO WHELAN and ARTHUR JOHN SEDANI

(54) PROCESS FOR PRODUCING COATED HEAT FUSIBLE FOAM SHEET

(71) We, STANDARD OIL COMPANY, of 910, South Michigan Avenue, Chicago, Illinois, 60680, United States of America, a corporation organized and existing under the laws of the State of Indiana, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

THIS INVENTION relates to a process for producing coated heat fusible plastics foam sheet.

In the early stages of developing extruded heat fusible foam sheet such as polystyrene foam sheet it appeared that if properties of high gloss and high strength could be imparted to one surface of the sheet, dishes and the like, having a desirable china-like surface, could be thermally formed and trimmed from the sheet. It was found that coating the heat fusible foam sheet with a resinous polymeric material would provide the desired strength and gloss properties. The physical properties of the product of coating heat fusible foam sheet with resinous polymeric materials were found to be superior to the properties of either of the heat fusible foam sheet or the resinous polymeric material alone. The gloss, rigidity, abrasion resistance and cut resistance of extruded polystyrene foam sheet were substantially improved with a resinous polymeric material coating, and, conversely, a resinous polymeric material film was substantially improved in its insulative properties rigidity and toughness when combined with an extruded foam polystyrene substrate. Previously heat fusible foam sheets have been coated on one side only, since typical coating processes could not be used to coat the second side. However, the desirable properties obtained by coating one side of a heat fusible foam sheet would be significantly increased by coating the second side, since such sheets coated on both sides would lend themselves to being formed into products which are superior to products formed from single side coated foam sheets.

According to the invention there is provided a process for producing heat fusible foam sheet material coated on both sides with resinous polymeric material, which comprises coating each side of the heat fusible foam sheet by extruding molten resinous polymeric material from a flat film die whilst continuously passing the heat fusible foam sheet past the die; contacting the heat fusible foam sheet and the resinous polymeric material so as to form a layer of resinous polymeric material in the heat fusible foam sheet and compressing the contacted heat fusible foam sheet and resinous polymeric material, the linear tension of the sheet and the extent to which the sheet is reverse-wrapped being adjusted to prevent the formation of wrinkles and cracks in the surface of the coated sheet.

To "reverse-wrap" as used in the specification and claims means to wrap the heat fusible foam sheet in a roller or multiplicity of rollers so that it forms an arc, and, in the case of a continuous coating process, changes the direction of travel of the sheet by more than 90 degrees. To avoid cracking of the coating and sheet the diameter of the arc must not be too small. The minimum diameter varies with the number of coated sides and thickness of the sheet. Thus, for example the ratio of arc diameter to thickness of a reverse wrapped heat fusible foam sheet coated on one side is preferably not less than 180 and the ratio of arc diameter to thickness of a reverse wrapped heat fusible foam sheet coated on two sides is preferably not less than 240. The tension on the sheet is preferably between 6 and 20 pounds per linear inch, and the linear speed of the sheet is preferably from 100 to 2000 feet per minute.

In carrying out the process of the invention, which it will be appreciated enables the production of heat fusible foam sheet coated on both sides with resinous polymeric

[Price 25p]

material, resinous polymeric material may be heated in an extruder of the type in common use in the plastics industry, having a heating means and a compression means. Thus, resinous polymeric material may be melted in an extruder whereupon it is forced out of the barrel and through a flat film die under a pressure in the range of from 1,000 to 5,000 pounds per square inch. As used in the specification and claims the term "melted" means plasticized by heat until extrudable. The flat film die desirably has a gap or opening of from 9 to 100 thousandths of an inch and an effective width approximately equal to the width of the heat fusible foam sheet to be coated. The die can be provided with conventional heating means.

The molten resinous polymeric material is continuously extruded through the die and onto the heat fusible foam sheet which is moving past the die. The coated polystyrene foam is then compressed between two rollers, a nip roller and a chill roller. The nip roller is preferably heated to between 100° and 200° F. and the chill roller is preferably cooled to between 40° and 80°F. The temperature of the rollers should be controlled so that the polymeric resinous material does not cool so much that it cannot melt a thin layer of the heat fusible foam sheet and fuse thereto, and in this connection reference is made to our co-pending U.K. Application No. 5323/71 (Serial No. 1,346,780). The clearance between these two rollers, which causes the polymeric resinous material and the heat fusible foam sheet to be compressed is commonly referred to as the nip. In the practice of this invention the nip pressure per linear inch must be adequate to press the coating into the foam substrate. Such a nip pressure is that generally sufficient to compress the coated foam sheet to about one-half its normal thickness. The foam, being resilient, regains a majority of its original thickness after being compressed. After compression the laminate is held in contact with the chill rollers which cools it and which can also impart desirable surface characteristics to the polymeric resinous layer. For example, if a mirror surface is desired a highly polished chill roller should be used.

There are, in particular two modes of practice of this invention. One, is using a two extruder line; the other, is, using a one extruder line and running the one side-coated heat fusible foam sheet through a second time. It should be clear that the design of the single extruder line must, in accordance with the invention, enable the second side of a one-side coated heat fusible foam sheet to be coated, even though a different design would be suitable for coating only one side. If a two extruder line is used it is necessary to reverse wrap the one-side coated heat fusible foam sheet at least once so that its underside can be exposed to a second extruder in the line.

In either mode of practice of this invention it may become necessary to reverse wrap the laminate product having both sides coated. Such necessity may arise from a desire to change the direction of travel of the laminate, so that overall movement of the heat fusible foam sheet is unidirectional, or from a desire to wind the laminate product on a roll for convenience of shipping. When such reverse wrapping is desired, the arc of the two-side coated laminate must be even more carefully controlled than when reverse wrapping the one-side coated heat fusible foam sheet.

The tension on the coated heat fusible foam sheet must be carefully controlled to ensure a wrinkle free product. The bond between the resinous polymeric material and the second side of the heat fusible foam sheet is formed in the same way as the bond between the resinous polymeric material and the first side, that is, the surface of the heat fusible foam sheet is melted when contacted by the extruded resinous material and, upon cooling it bonds the resinous material thereto.

The process of the invention will be described in more detail with particular reference to the accompanying drawings in which:

Figure 1 is a schematic elevation of a coating machine having a single extruder, and

Figure 2 is a schematic elevation of a coating machine having two extruders. In Figure 1 the heat fusible foam sheet 10 travels from an unwind station 11 through a tension control 12 and onto a nip roller 14, which is a roller that forms a nip or compression means with a second roller. The heat fusible foam sheet 10 is then coated with polymeric resinous material extruded through a flat film die 15 attached to extruder 13. The coated sheet 16 is then transferred to a chill roller 17 which is a cooled roller opposite the nip roller which forms a part of the compression means and also imparts desirable surface characteristics to the coating. The coated heat fusible foam sheet 16 is next transferred to a third roller 18 which enables it to remain in contact with the chill roller 17 for about one-half of its circumference. The coated side having been last coated does not contact the surface of the third roller 18. The three rollers referred to above are externally powered to impart motion to the heat fusible foam sheet 10. The coated sheet 16 is then passed through tension control 19 and wound upon a rewind roll at the rewind station 20 and transferred back to the unwind station 11 to be coated on the other side.

In Figure 2 the heat fusible foam sheet 20 travels from an unwind station 21 through a first coating station comprising roller 1, nip roller 2, chill roller 3, extruder 29 and rollers 4 and 5. The one-side coated heat

fusible foam sheet 22 from the first coating station passes roller 6 through a tension control 23 and is reverse wrapped on roller 7. It then passes on to nip roller 8 which is a roller that forms a nip or compression means with a second roller. While the one-side coated heat fusible foam sheet is upon the nip roller 8, its second side is coated with a polymeric resinous material extruded through a flat film die 26 attached to extruder 28. The two-side coated sheet is then transferred to a chill roller 9 which is a cooled roller opposite the nip roller which forms a part of the compression means and also imparts desirable surface characteristics to the coating. It is also reverse wrapped on each of these rollers. The heat fusible foam sheet is then passed on to a third roller 10 which enables it to remain in contact with the chill roller for about one-half of its circumference. The coated side having been last coated does not contact the surface of the third roller. The nip roller 8, the chill roller 9 and the third roller 10 referred to above are all externally powered to impart motion to the heat fusible foam sheet. The two-side coated heat fusible sheet 27 is then passed on to roller 11 where it is reverse wrapped to give it a unilateral direction in the overall process. Next the two-side coated heat fusible foam sheet 27 is run on roller 12 and roller 13 through a tension control 24 and onto a rewind roll at the rewind station 25.

Preferably, the extruder has a barrel, a heating means and a compression means. The compression means of the extruder is an auger contained inside the barrel having from 18 to 30 flights (revolutions of the helical inclined plane along the length of the barrel). The heating means is either an electric or oil heater positioned outside and along the barrel to create independently controlled heat zones inside the barrel. Some heat is also provided by working of the material in the auger compression means. The barrel temperature should be between 400° and 475°F., the barrel having an inside diameter of between 1 and 12½ inches. The polymeric resinous material can thus be extruded in a continuous operation.

It is preferred that extrusion be through a heated flat film die. The temperature of the die is held between 375° and 500°F. by either an electric or an oil heater and preferably the resinous-polymeric material is extruded at a temperature of about 450°F. The pressure inside the die will generally fall in the range of 1,000 to 5,000 psi depending upon the polymeric resinous material used. The die pressure is preferably 1,500 psi. The gap (opening) in the die is approximately 2 to 100 thousandths of an inch, preferably 10 thousandths, with the width of the die varying with the width of the heat fusible foam sheet to be coated.

For best results it is important that the molten resinous coating material contact the heat fusible foam sheet while it is still on the nip roller. Contacting the two materials at this point insures that the resinous polymeric material will contact the foam sheet while it is being held smooth and free from wrinkles. The product will then be free of wrinkles and surface imperfections. It has also been found that rotating the nip roller between 0 and 10% slower (based on the surface speed) than the chill roller and the third roller between 0 and 10% faster (based on the surface speed) than the chill roller results in a more smooth and uniform product. It has been found that about 2% variance in speed (based on the surface speed) is the optimum. In addition, the tension on the heat fusible foam sheet is controlled by two tension controls (shown in the figures). The preferred tension on the coated sheet coming off the rollers is between 6 and 20 pounds per linear inch.

The linear speed of the heat fusible foam sheet as it travels from the unwind station to the rewind station is dependent upon the thickness of the polymeric resinous material to be applied, the output of the polymeric resinous extruder and the capabilities of the unwind station and the rewind station (shown in the figures). Speeds can range from 100 to 2000 feet per minute depending upon these variables.

Various heat fusible foam sheets can serve as the substrate in the coating process of this invention. The following are examples of the more important foams which can be coated: polystyrene, styrene copolymers, polyethylene, polypropylene and polyvinylchloride. It should be noted, however, that polyethylene and polypropylene foam sheets are only effective as substrates when they are being coated with polyethylene and polypropylene respectively. Similarly, polyethylene and polypropylene are only effective as coating materials when polyethylene and polypropylene foam sheets are the respective substrates.

The compression of the polymeric resinous material onto the heat fusible foam sheet substrate may be effected without nip compression by increasing the linear tension of the foam substrate, thereby causing the polymeric material to be compressed slightly as it is wrapped between the nip roll and the foam substrate. Suitable polymeric resinous materials are acrylonitrile - butadiene - styrene copolymer, acrylonitrile - styrene (copolymer), polyvinylchloride, crystalline polystyrene, polyethylene, polypropylene or rubber modified polstyrene. The polyethylene and polypropylene are, of course, limited to polethylene polypropylene substrates respectively.

EXAMPLE I

Referring to Figure I, the following table shows the minimum arc diameters which can be used in conjunction with one-side coated heat fusible foam sheets of various thicknesses in a one extruder line while coating the second sides thereof.

	Heat Fusible Foam Sheet Thickness in Mils		
	Below 50	50—75	76 to 99
Roller Number	Arc Diameter, inches		
6	9	15	24
14	9	15	24
17	12	18	30
18	12	18	30
Roller at unwind station 11	9	15	24
Roller at rewind station 20	12	18	30
All other rollers	6	12	18

The process described and set forth in Figure I using the above arc diameters for various thicknesses of heat fusible foam sheet substrate results in a successful commercial operation.

EXAMPLE II

Referring now to Figure II, the following table shows the minimum arc diameters which can be used in conjunction with heat fusible foam sheets of various thicknesses through the entire coating process.

	Heat Fusible Foam Sheet Thickness in Mils		
	Below 50	50—75	76 to 99
Roller Number	Arc Diameter, inches		
1	6	12	18
2	6	12	18
3	36	36	36
4	9	15	24
5	9	15	24
6	9	15	24
7	9	15	24
8	9	15	24
9	36	36	36
10	12	18	30
11	12	18	30
12	12	18	30
13	12	18	30
Roller at rewind station 25	12	18	30
All other rollers	6	12	18

The process described and set forth in Figure II using the above roller diameters for various thicknesses of heat fusible foam sheet substrates results in a successful commercial operation.

In Examples I and II the ratio of arc diameter to heat fusible foam sheet thickness is never less than 180 when a one-side coated heat fusible foam sheet is reverse wrapped. The ratio of arc diameter to heat fusible foam sheet thickness is never less than 240 when a two-side coated heat fusible foam sheet is reverse wrapped.

Reverse wrapping occurs in Figure I of Example I at rollers 14, 17, 18 and the roller at the rewind station. It being understood that in Example I the roller at the unwind station will have a reverse wrapped one-side coated heat fusible foam sheet thereon when the second side is being coated, and corresponding rollers 17, 18 and the roller at the rewind station will have the two-side coated heat fusible foam sheet reverse wrapped thereon. Reverse wrapping in Figure II of Example II occurs at rollers 2, 3, 7, 8, 9, 11 and the roller at the rewind station.

WHAT WE CLAIM IS:—

1. A process for producing heat fusible foam sheet material coated on both sides with resinous polymeric material, which comprises coating each side of the heat fusible foam sheet by extruding molten resinous polymeric material from a flat film die whilst continu-

ously passing the heat fusible foam sheet past the die; contacting the heat fusible foam sheet and the resinous polymeric material so as to form a layer of resinous polymeric material on the heat fusible foam sheet and compressing the contacted heat fusible foam sheet and resinous polymeric material, the linear tension of the sheet being adjusted and the extent to which the sheet is reverse-wrapped being limited to prevent the formation of wrinkles and cracks in the surface of the coated sheet.

2. A process according to Claim 1 wherein the extruded resinous polymeric material is applied to both sides of the heat fusible foam sheet by passing the heat fusible foam sheet past a single extruder twice, a different side being coated on each pass.

3. A process according to Claim 1 wherein the extruded resinous polymeric material is applied to both sides of the heat fusible foam sheet by passing the heat fusible foam sheet past two extruders, one extruder being arranged to provide a coating for one side and the other extruder being arranged to provide a coating for the other side.

4. A process according to any preceding claim wherein the ratio of arc diameter to thickness of a reverse wrapped heat fusible foam sheet coated on one side is never less than 180.

5. A process according to Claim 4 wherein the ratio of arc diameter to thickness of a reverse wrapped heat fusible foam sheet coated on two sides is never less than 240.

6. A process according to any preceding claim wherein the resinous polymeric material is acrylonitrile - butadiene - styrene copolymer, acrylonitrile - styrene copolymer, polyvinylchloride, crystalline polystyrene or rubber modified polystyrene.

7. A process according to any preceding claim wherein the heat fusible foam sheet is polystyrene, styrene copolymers or polyvinylchloride.

8. A process according to any preceding claim wherein the polymeric resinous material is extruded at a temperature of about 450°F.

9. A process according to any preceding claim wherein the polymeric resinous material is extruded through the flat film die or dies under a pressure of between 1,000 and 5,000 pounds per square inch.

10. A process according to claim 9 wherein a pressure is about 1,500 pounds per square inch.

11. A process according to any preceding claim wherein a roller means is used to pass the heat fusible foam sheet past the flat film die during the coating process.

12. A process according to any one of claims 1 to 10 wherein the heat fusible foam sheet and the resinous polymeric material are compressed by a roller means.

13. A process according to claim 11 or claim 12 wherein the roller means is comprised of a nip roller and a chill roller.

14. A process according to claim 11 or claim 12 wherein said roller means is comprised of a nip roller, a chill roller, a third roller and a rewind roller.

15. A process according to any one of claims 12 to 14 wherein the nip roller is heated to between 100 and 200 F.

16. A process according to any one of claims 12 to 15 wherein the chill roller additionally cools the coated heat fusible foam sheet and imparts desirable surface characteristics to the side last coated.

17. A process according to any one of claims 12 to 16 wherein the chill roller is maintained at a temperature between 40° and 80°F.

18. A process according to any preceding claim wherein the linear speed of the heat fusible foam sheet is from 100 to 2000 feet per minute.

19. A process according to any preceding claim wherein the tension on the sheet is between 6 and 20 pounds per linear inch.

20. A process according to any preceding claim wherein the resinous polymeric material and the heat fusible foam sheet are compressed sufficiently to press the resinous polymeric material into the heat fusible foam sheet.

21. A process according to any preceding claim wherein the heat fusible foam sheet is polyethylene and the resinous polymeric material is polyethylene.

22. A process according to any of claims 1 to 20 wherein the heat fusible foam sheet is polypropylene and the resinous polymeric material is polypropylene.

23. A process for coating two sides of a heat fusible plastics foam sheet substantially as hereinbefore described and exemplified.

24. A process for coating two sides of a heat fusible plastics foam sheet substantially as hereinbefore described with particular reference to either of Figures 1 and 2 of the accompanying drawings.

25. A coated sheet whenever produced by a process according to any preceding claim.

MATHYS & SQUIRE,
Chartered Patent Agents,
10, Fleet Street,
London, EC4Y 1AY,
Agents for the Applicants.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1974.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

19

1348271 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

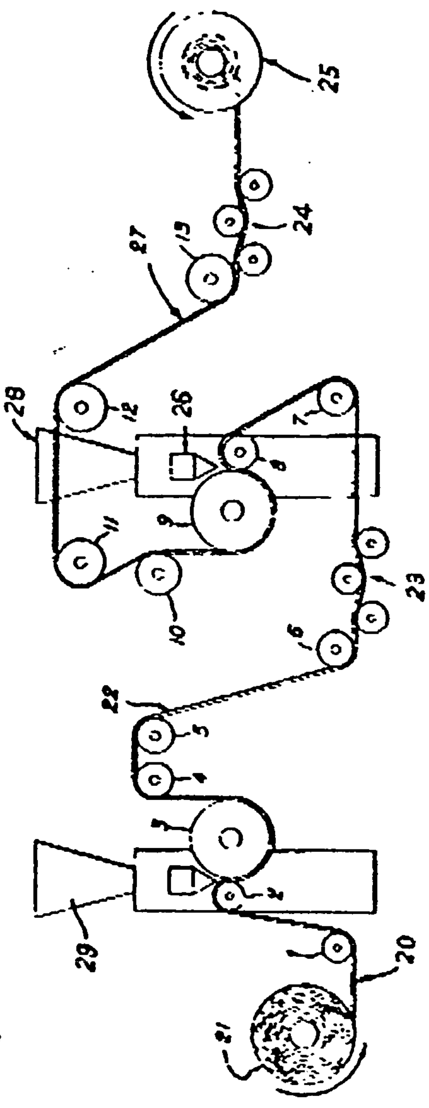

Fig. 2

1348271 COMPLETE SPECIFICATION

2 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 1

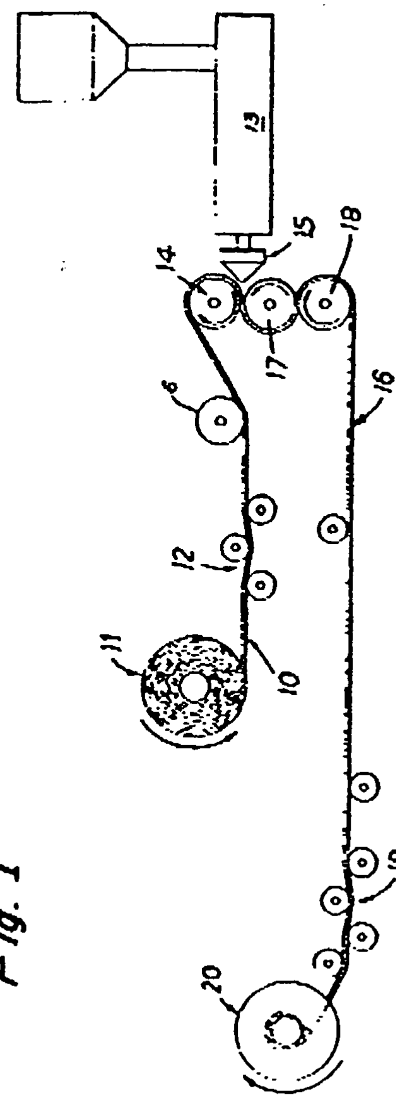

Fig. 1